MULTICAL® Compact

Technical Description

Kamstrup

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1. General description

MULTICAL® Compact is a static ultrasonic heat meter intended for energy measurement in all types of heating installations with water as heat carrying medium. The construction is based on Kamstrup's long experience with the ultrasonic flow meter ULTRAFLOW® II and the integrating unit MULTICAL® III.

The energy meter is based on ultrasonic measurement and microprocessor technique. All circuits for calculation, temperature and flow measurement are gathered in a single-board construction providing a compact and rational design, and at the same time supreme measuring quality and reliability are achieved.

The volume measurement is carried out by means of bidirectional ultrasound technique according to the transit time method which is today considered the most long-term stable measuring principle within the trade. Two ultrasonic transducers send ultrasonic signals with and against the flow direction. The ultrasonic signal travelling in the flow direction will reach the opposite transducer first, and the time difference between the two signals can subsequently be converted into a flow quantity.

The temperatures in flow and return pipes are measured by accurately matched Pt500 sensors according to DIN/IEC 751. The short direct sensor has been constructed in accordance with EN 1434-2 and therefore fits many standard ball valves and fittings. One temperature sensor is mounted direct in the flow part, which simplifies the installation.

The accumulated thermal energy can be displayed in kWh, MWh or GJ, all including seven significant digits and the measuring unit. The display has been specially constructed with a view to long lifetime and high contrast in a wide temperature range. Other possible display indications are accumulated water consumption, operating hours, current temperature, flow and power measurements. Furthermore, MULTICAL® Compact can be configured to read out target data, peak power, information code, date and a user-defined tariff.

For safety reasons all registers are stored every hour in an EEPROM that also includes monthly data for the last two years.

MULTICAL® Compact has been constructed with two ports for data communication. The optical eye at the front makes reading of consumption data and data logger as well as online serial PC connection through configuration of the energy meter possible.

Furthermore, a duplex multi-conductor plug is placed under the top cover. The top part of this plug is used in connection with verification, whereas the bottom part is used for connection of communication modules with M-bus or RS232 interface.

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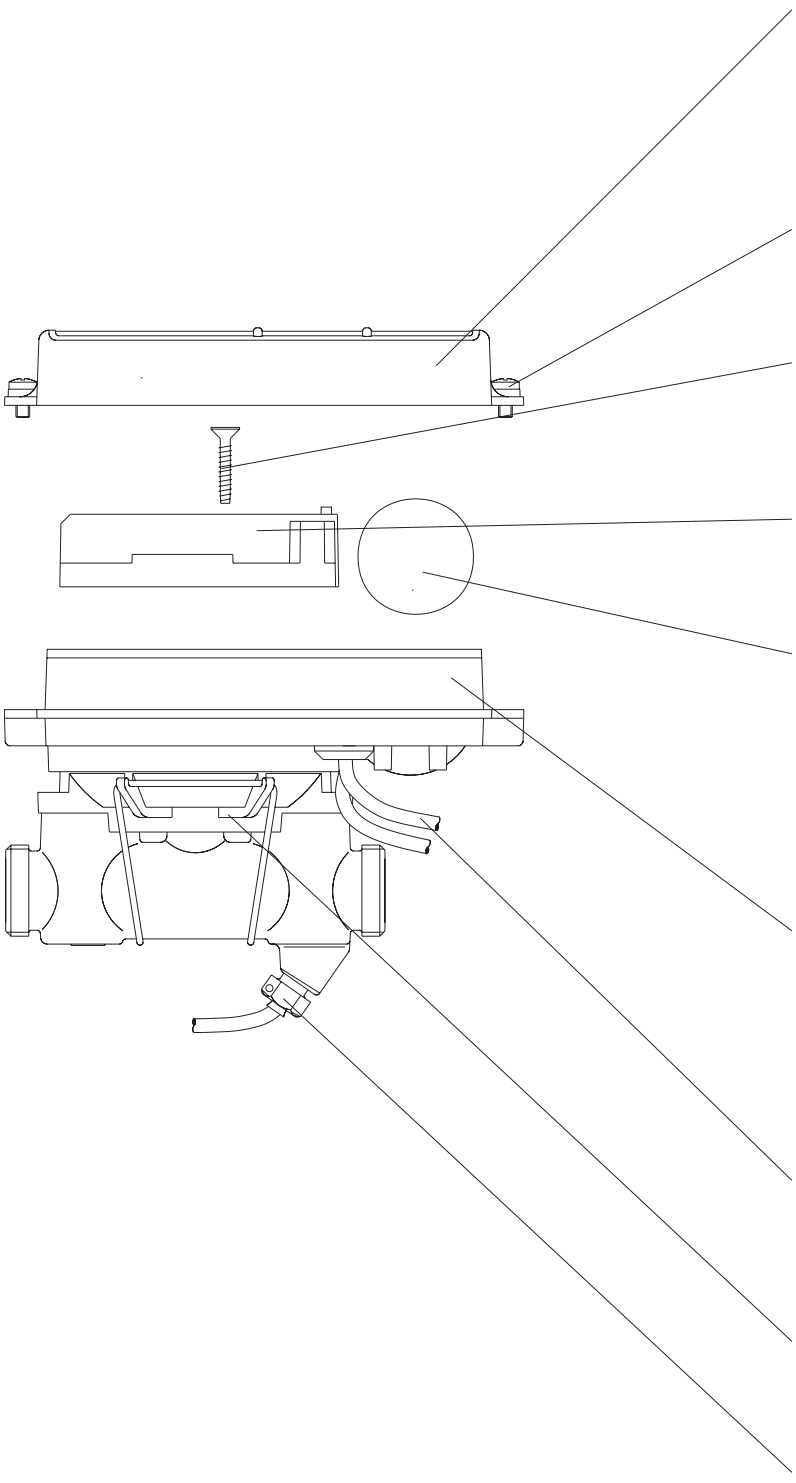
1.1 Mechanical construction



Top cover
During installation it can be necessary to remove this cover, e.g. in connection with the installation of data cables or battery change. After installation the top cover must be sealed at both sides by means of seal and thread.

Screws for the cover
(PZ-2) The top cover is fastened by means of 2 posidrive screws. After installation the screws must be tightened.

Sealing screw
(Torx-20) The sealing screw, with which the sealing cover is fastened, is covered by a sealing label. Please note that verification and factory guarantee are only valid, if this label is unbroken.

Cover
The sealing cover prevents access to the MULTICAL® Compact parts which are not used in connection with installation.

Supply
MULTICAL® Compact can be supplied through either a built-in lithium battery, a 24 VAC/DC module or a 230 VAC module. Also see the list of type numbers. The meter must always be supplied with approx. 3.6 VDC on terminals 60 (+) and 61 (+) by one of the above-mentioned modules. External power sources must never be connected directly to terminals 60 and 61.

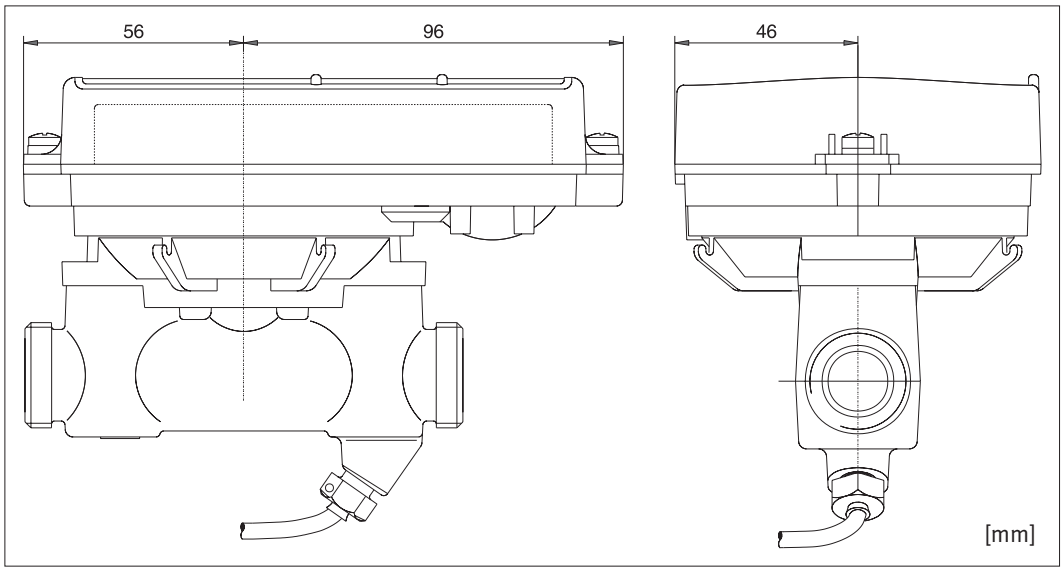
Meter case
All circuits for calculation, temperature and flow measurement are placed in the meter case, which cannot be separated from the flow part. The meter case can be turned 270° in relation to the flow part, and it is thereby always possible to obtain excellent display reading, whether MULTICAL® Compact is installed in a horizontal or vertical pipe.

Sensor cable
The two temperature sensors are supplied with silicone cable which is extremely resistant to heat. Also see section 2.7 regarding installation of the sensors.

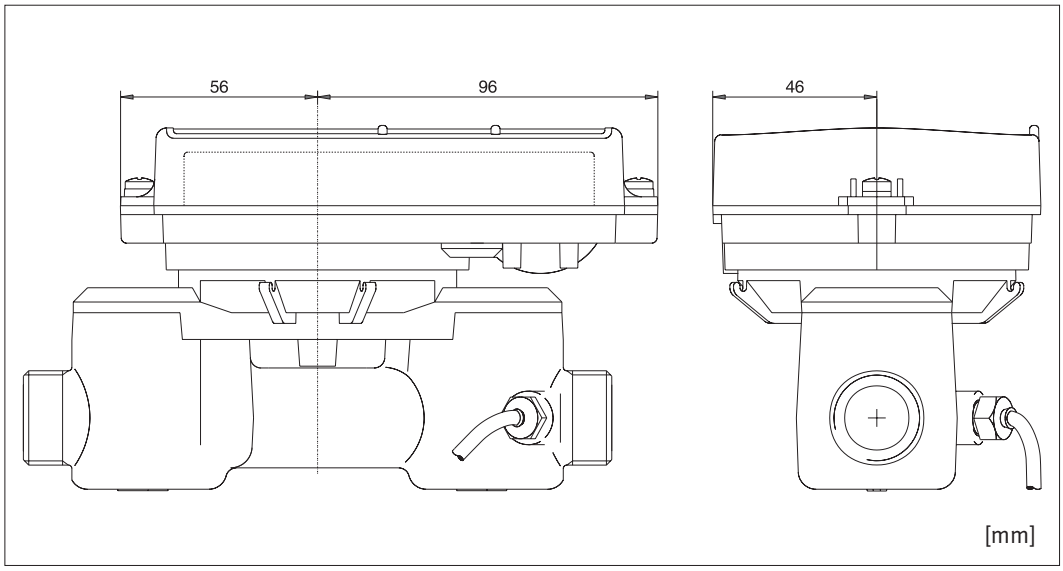
Cable bearer
The temperature sensors are supplied with cable in standard lengths. Excess cable can be rolled up and fastened with the cable bearer.

Sensor socket
One of the energy meter's two temperature sensors is mounted directly in the flow part, which simplifies the installation. As the flow part can be mounted in both flow and return pipe, depending on the chosen programming, it is important to check that the correct sensor has been mounted in the flow part.

1.1.1 Dimensional sketch 110 and 130 mm meter



1.1.2 Dimensional sketch 165 mm meter



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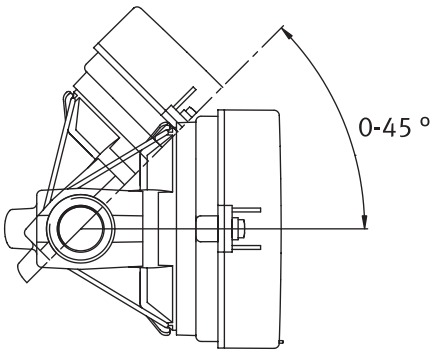
1.2 Installation requirements

Before mounting MULTICAL® Compact flush the system thoroughly with a fitting tube mounted instead of the energy meter. Then remove the protection caps from the meter and mount it by means of Kamstrup's original brass screw-joints and corresponding fibre gaskets.

If other types of screw-joints or extension nipples are used it must be checked that the thread length of the screw-joint does not prevent the sealing surface from being sufficiently tightened. Concerning thread lengths in connection with MULTICAL® Compact see the dimensional sketches.

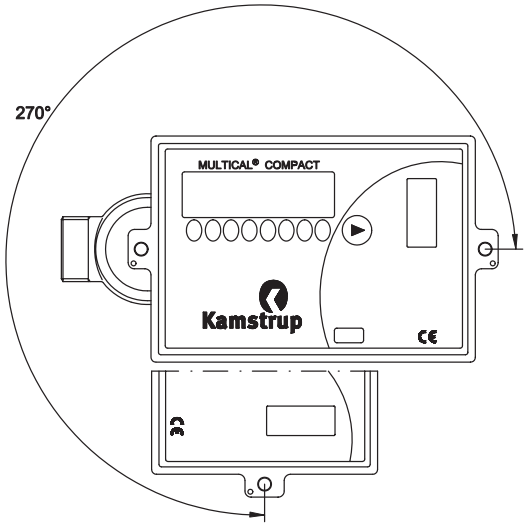
Correct position of the flow part, in flow or return pipe, appears from the type sign on the side of the meter, and the flow direction is shown by an arrow cast in the back of the flow part.

MULTICAL® Compact should be mounted with the display vertical or at an angle of max. 45°. When mounted in heating systems with watertreatment and minimal risk of air, e.g. directly connected district heating systems, the display may be mounted horizontally. Straight inlet conditions are not required.



MULTICAL® Compact can be mounted in horizontal, vertical and sloping pipes.

After being mounted the display can be turned up to 270° to optain a better reading.



The electronics can be turned 270° based on horizontal installation with the electronics pointing upwards.

Permitted operating conditions

Ambient temperature	0...55°C
Optimum battery life	0...35°C
Temperature of the medium	20...90°C
Max. system pressure	16 bar

EMC conditions

MULTICAL® Compact is intended for installation in residential houses as well as in light industrial environments and the meter is CE-marked according to EN 1434 as well as low-voltage regulations. Control cables must be drawn at a distance of 25 mm from other installations.

Electrical Installation

MULTICAL® Compact is available for both 24 VAC/DC and 230 VAC mains supply. The version appears clearly from the mains module which is placed under the top cover to the right. The connection consists of a two-wire cable without earth connection. Use a connection cable with an outer diameter of max. 7 mm and make sure that the correct cable retainer is used in the meter.

230 VAC must only be connected to screw terminal nos. 27 and 28 of the mains module

National regulations for electrical installations must always be observed.

Service

When the meter has been mounted in the heating system neither welding nor freezing is permitted. Before starting such work dismount the meter from the heating system and disconnect the mains supply, if any.

In order to facilitate possible service on the meter, closing valves ought to be mounted on both sides of the meter.

Under normal operating conditions no line strainer is required in front of the meter.

2. Functional description

2.1 Measurement and calculation

MULTICAL® Compact uses time based integration, i.e. the calculations of used water quantity and consumed thermal energy are carried out at fixed intervals. During normal operation the meter carries out its calculations every 30 sec. whereas it accelerates the calculation rate in verification mode (see section 5 on verification).

Flow measurement
During flow measurement the phase displacement between the sound signals, with and against the current respectively, is determined. A flow measurement consists of several sequences.

- First several sound signals are sent both with and against the current in order to determine the transit time difference.
- Subsequently the measuring signal is corrected in relation to actual water temperature and internal calibration constants before the flow measurement is transferred to the internal high resolution volume register.

Temperature measurement
Flow and return temperatures are measured by means of an accurately matched set of Pt 500 sensors. During the measurement itself approx. 0.5 mA current is sent through the sensors. Two measurements are carried out, one 50 ms. after the other, in order to suppress 50 Hz hum, accumulated in the sensor cables.

When the measuring current runs through the sensors, < 0.2 mW peak power is deposited in each sensor, corresponding to an average power of < 10 µW under normal operation or < 40 µW in verification mode.

Measurement of references
MULTICAL® Compact includes reference circuits for both ultrasonic flow measurement and temperature measurement. The references are used in all measuring sequences and are therefore measured every 30 sec. in normal mode and approx. every 4 sec. in verification mode. Furthermore, reference measurements of precision resistors are carried out every two minutes in order to optimize measuring accuracy and long-term stability.

Normal Mode [sek.]	Operation
30	*Volume and energy calculation*
0	Flow measurement
1	Flow measurement
3	Flow temperature
5	Flow measurement
6	Flow measurement
8	Return measurement
10	Flow measurement
11	Flow measurement
13	Measurement of references
15	Flow measurement
16	Flow measurement
20	Flow measurement
21	Flow measurement
25	Flow measurement
26	Flow measurement
30	*Volume and energy calculation*
0	Flow measurement

The individual measurements and calculations which are carried out every 30 sec.

Volume and energy measurement
During each measuring sequence the water flow is measured 12 times, and in the internal high-resolution volume register the water quantity which has passed through is summed up with a resolution of 0.001 l (1 ml), whereas the display register is updated with a resolution of 0.001 m³. After each volume calculation the thermal energy is calculated. The energy calculation is based on the temperature difference measured during the period in question, the measured volume as well as the water's heat coefficient at the temperature measured.

Example:
MULTICAL® Compact, programmed for forward flow. Actual water flow at 312 l/h (2.6 l/30 sec.), t_F=72.42°C and t_R=34.81°C. Accumulated energy per 30 sec. is calculated as follows,

Energy = (Δt [K] × Vol [ml] × k [MJ/m°/K]) /3600 [Wh]

= (37.61 × 2600 × 4.0832)/3600 = <u>110.94 [Wh]</u>

The K-factor appears from "Tabellen von Wärmekoeffizienten für Wasser als Wärmeträgermedium" ISBN 3-88314-522-X. Re EN 1434-1 only table values calculated at 16 bar system pressure can be used.

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2.2 Push buttons

MULTICAL® Compact has two push buttons, one front key for display change and an internal push-button used during verification (see paragraph 5 verification).

During normal operation the display shows accumulated thermal energy in kWh, MWh or GJ, depending on the selected programming. Activating the front key the display will move on to accumulated volume, hour counter, forward and return temperatures etc. (see paragraph 3.2 display indications). If the front key is activated for 5 sec. the display changes to a submenu with indication of secondary registers, e.g. target data, tariffs and customer number.

Front key for display change

2.3 Display function

The MULTICAL® Compact display includes both a main menu and a sub-menu. In addition to thermal energy and accumulated volume the main menu can include hour counter, temperature, power and flow indications. If the front key is pressed briefly, the display moves through the indications. The sub-menu is activated by pressing the front key continuously for 5 sec. Afterwards the front key can be used to go through the sub-menu's indications.

When the sub-menu has been selected, an "A" will appear in the left side of the display.

No matter which indication you have selected in main menu or sub-menu, the display will automatically return to the indication of accumulated thermal energy, if the front key is not activated for 150 sec.

The contents of both main and sub-menues are determined by the configuration chosen for the meter (see paragraph 3.3 display indications).

2.4 Information codes "E"

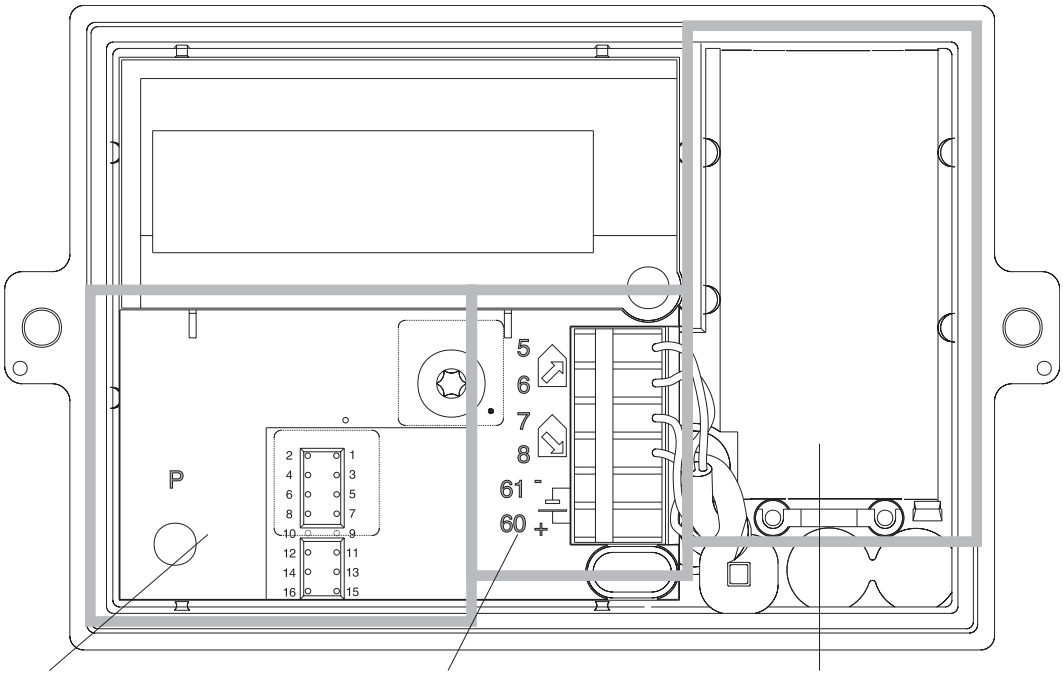
MULTICAL® Compact constantly checks a series of vital functions, whereby serious system errors can be detected. Should one or several serious errors occur in the energy meter, the display will show an "E" at the left side. In case of short-duration errors the "E" will only be displayed as long as the error exists. If an error situation has existed for more than an hour, the information code will be permanent and can now only be deleted by opening the meter (see paragraph 2.6 reset functions). When the first permanent information code occurs, it is stored in the EEPROM together with the date and the energy and volume registers at the time the error occurred.

The meter's current "info-code" appears from the last display indication in the main menu, i.e. when the front key has been activated 4-10 times depending on the selected display configuration.

During normal operation the meter shows "000 info". If one or more of the following-mentioned errors occur, the sum of the information codes is shown. E.g. a simultaneous error in both temperature sensors is shown as "012 info".

+0	No errors found.
+2	The information code indicating flow meter error is activated when the water flow has been below cut-off continuously for 48 hours, whilst Δt has been › 20 K.
+4*	The return sensor does not comply with its measuring range, 0...150°C. The sensor can be short-circuited or disconnected.
+8*	The flow sensor does not comply with its measuring range, 0...150°C. The sensor can be short-circuited or disconnected.
+16*	Air has been found in the flow meter (is only indicated as long as the error exists).
+128	The battery should be replaced. This code occurs 9 years after the hour counter has been reset.
*)	These information codes can occur during transportation below freezing point as well as during storage. During installation the info-codes are reset as described in paragraph 2.6 Reset functions.

2.5 Dismounting the top cover



2.5.3 Multiple plug, seal and module area

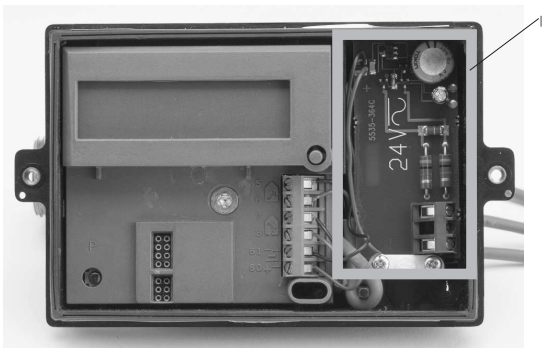
2.5.2 Screw terminals

2.5.1 Supply modules

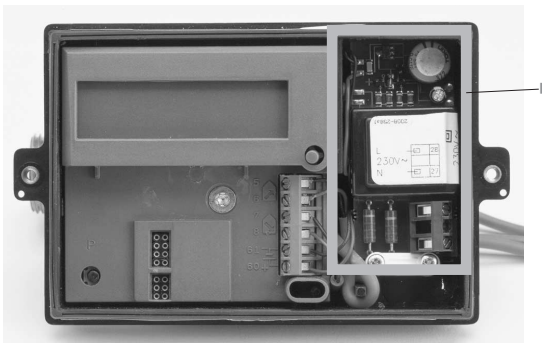
2.5.1 Supply modules

MULTICAL® Compact must always be supplied internally with approx. 3.6 VDC through terminals 60(+) und 61(-). This is obtained through one of the following supply modules:

Built-in D-cell lithium battery
A standard lithium D-cell can be used in the meter. The battery is placed in the right side of the connecting bracket and is easily replaced solely using a screw driver.



24 VAC/DC supply module
The energy meter includes a print module which reduces the input voltage to approx. 3.6 VDC. The module has built-in transient protection, but includes no galvanic separation between input and output voltage. The module is specially suited for installation together with a galvanically separated transformer, e.g. type 66-99-400 which can be installed in the switch cabinet. When the transformer is used the total power consumption of the meter will be less than 4 VA/1.5 W.



230 VAC supply module
This print module is galvanically separated from the mains supply and is suitable for direct mains installation. The module includes a double-chamber safety transformer which fulfils the requirements to double-insulation. The power consumption is less chan 1VA/1W.

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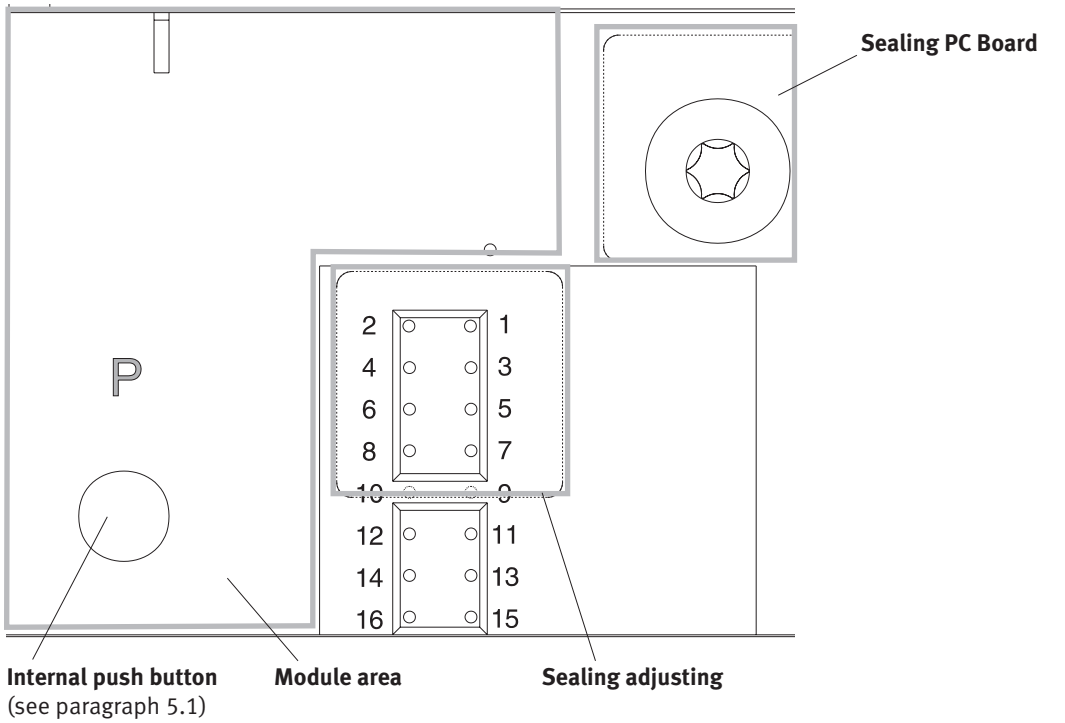
2.5.2 Screw terminals (A)

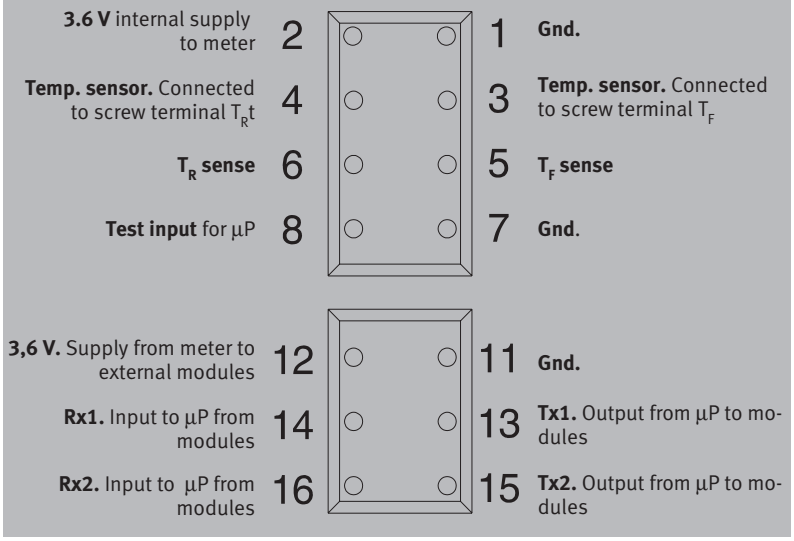
MULTICAL® Compact has 6 screw terminals

No.	Colour	Type
5		Flow sensor
6		Flow sensor
7		Return sensor
8		Return sensor
61	Black	Supply (-)
60	Red	Supply (+)

2.5.3 Multiple plug, seal and module area



Multiple plug



2.6 Reset functions

MULTICAL® Compact includes a "Power On Reset" circuit which is activated every time the supply power is switched on. This reset function only resets the internal high-resolution registers and therefore does not influence the display registers. After each "Power On Reset" all registers are loaded from the EEPROM thereby securing that the meter always starts up with hour data from the EEPROM.

If the "Power On Reset" function is combined with activating the front key or the internal verification button, the following reset functions are obtained.:

Action	Function
Reset + front key	Reset info-code
Reset + verification button	Reset info-code and hour counter
Use Metertool	Total reset: Reset of info-code, hour counter, energy- and volume indication as well as back up and target data.

The reset function must not be carried out by short-circuiting the battery!

"Power On Reset" is carried out by loosening one of the screw terminals 60 or 61. When the display goes out, reestablish the connection and at the same time activate the required push button combination. Do not forget to fasten the screw terminals before mounting the top cover.

2.7 Temperature sensor

When the meter carries out the reset function all segments of the display light up to confirm correct reset procedure.

MULTICAL® Compact is supplied with a set of short direct Pt500 sensors constructed according to the European standard for thermal heat meters EN 1434-2. The sensors are intended for direct mounting in the measuring medium, i.e. without sensor pockets, which makes the response time very quick.

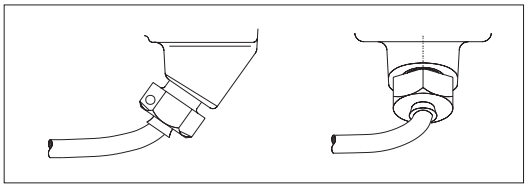
The connection cable is a ø3.5 mm 2-wire silicone cable. The sensor tube is constructed in stainless steel and the point, where the sensor element is placed, measures ø4 mm.

One sensor is placed directly in the flow part.

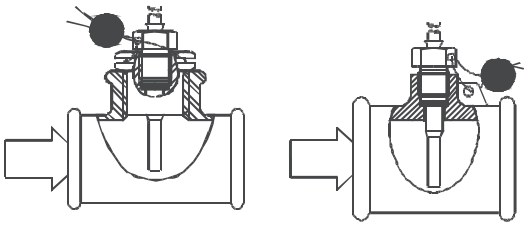
If MULTICAL® Compact has been programmed for mounting in the flow pipe (Prog = 3-B-CCC), the flow part must be placed in the flow pipe and the flow sensor with the red label must be mounted in the flow part.

If MULTICAL® Compact has been programmed for mounting in return pipe (Prog = 4-B-CCC), the flow part must be placed in the return pipe and the return sensor with the blue label must be mounted in the flow part.

The other sensor, return or flow respectively, is mounted in the pipe section by means of special T-pieces which are available for ½", ¾" and 1" pipe installations. Furthermore, the short direct sensor can be mounted by means of a R½ or R¾ for M10 Nippel in an ordinary 90° T-piece.



Flow part with 1434 sensor socket



Short direct sensor

Sensor cable

As mentioned above the temperature sensors are mounted with silicone cable which is both temperature resistant and flexible.

The conductor cross-section is 0.25 mm², which corresponds to a positive measuring error of approx. 0.08°C per meter. Flow and return sensor cables must have the same length. If not, the earlier-mentioned cable resistance will influence the measurement of the differential temperature.

In general we recommend that our temperature sensors are used with the cable lengths supplied from the factory as excessive cable can be rolled

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up and mounted by means of the cable retainers placed underneath MULTICAL® Compact.

If, after due consideration, the cables are shortened anyway, the sensor cables must be equally long after shortening.

Sensor element
MULTICAL® Compact is used with Pt500 temperature sensors according to DIN/IEC 751. A Pt500 temperature sensor is a resistance sensor, of which the nominal ohmic resistance is 500.000 Ω at 0°C and 692.528 Ω at 100°C. All values for the ohmic resistance are determined in the international standard DIN/IEC 751, wich applies to Pt100 temperature sensors. The values for the ohmic resistance of Pt500 sensors are five times higher and appear from the below-mentioned table in [Ω]:

°C	0	1	2	3	4	5	6	7	8	9
0	500.000	501.954	503.907	505.860	507.812	509.764	511.715	513.665	515.615	517.564
10	519.513	521.461	523.408	525.355	527.302	529.247	531.192	533.137	535.081	537.025
20	538.968	540.910	542.852	544.793	546.733	548.673	550.613	552.552	554.490	556.428
30	558.365	560.301	562.237	564.173	566.107	568.042	569.975	571.908	573.841	575.773
40	577.704	579.635	581.565	583.495	585.424	587.352	589.280	591.207	593.134	595.060
50	596.986	598.911	600.835	602.759	604.682	606.605	608.527	610.448	612.369	614.290
60	616.210	618.129	620.047	621.965	623.883	625.800	627.716	629.632	631.547	633.462
70	635.376	637.289	639.202	641.114	643.026	644.937	646.848	648.758	650.667	652.576
80	654.484	656.392	658.299	660.205	662.111	664.017	665.921	667.826	669.729	671.632
90	673.535	675.437	677.338	679.239	681.139	683.038	684.937	686.836	688.734	690.631
100	692.528	694.424	696.319	698.214	700.108	702.002	703.896	705.788	707.680	709.572
110	711.463	713.353	715.243	717.132	719.021	720.909	722.796	724.683	726.569	728.455
120	730.340	732.225	734.109	735.992	737.875	739.757	741.639	743.520	745.400	747.280
130	749.160	751.038	752.917	754.794	756.671	758.548	760.424	762.299	764.174	766.048
140	767.922	769.795	771.667	773.539	775.410	777.281	779.151	781.020	782.889	784.758
150	786.626	788.493	790.360	792.226	794.091	795.956	797.820	799.684	801.547	803.410

IEC 751 Amendment 2/ 1995-07

The advantages of using resistance sensors with a high ohmic value (Pt500) compared to resistance sensors with a low ohmic value (Pt100), are many, e.g.:

- less influence from cable resistance in sensor cables and contact resistance in connections
- increased ohmic change per °C improves the accuracy of the integrating unit's A/D converter
- improved possibility for exact matching of a temperature sensor set

Matching
The differential temperature forms part of the calculation of the heat quantity and must therefore be known very accurately.

The accuracy tolerances of the temperature sensor according to DIN/IEC 751 B are ±0.3°C at 0°C and ±0.8°C at 100°C. These tolerances are sufficient as far as the flow and return temperatures are concerned, as the deviation is in this connection only related to the k-factor used. However, the above-mentioned accuracy tolerances are far from sufficient when it comes to measuring the differential temperature, because the two temperature sensors used to measure the differential temperature must have the same deviation characteristics.

In practice this is secured as follows: First the temperature sensors are tested in a thermostat-controlled bath at 40°C and divided into 50 groups, determined by each sensor's deviation at this temperature. Each group has a tolerance zone of ±0.01°C. All sensors that were placed in the same group at 40°C are now tested in a thermostat-controlled bath at 130°C and divided into 32 groups of ±0.01°C, again determined by each sensors accuracy at 130°C. Subsequently, the individual sets of sensors are tested at 85°C. This is either done by random sampling or by testing all sensors, according to approval. Temperature sensors, which are in the same group both at 40°C and at 130°C, make out a sensor set which must never be separated.

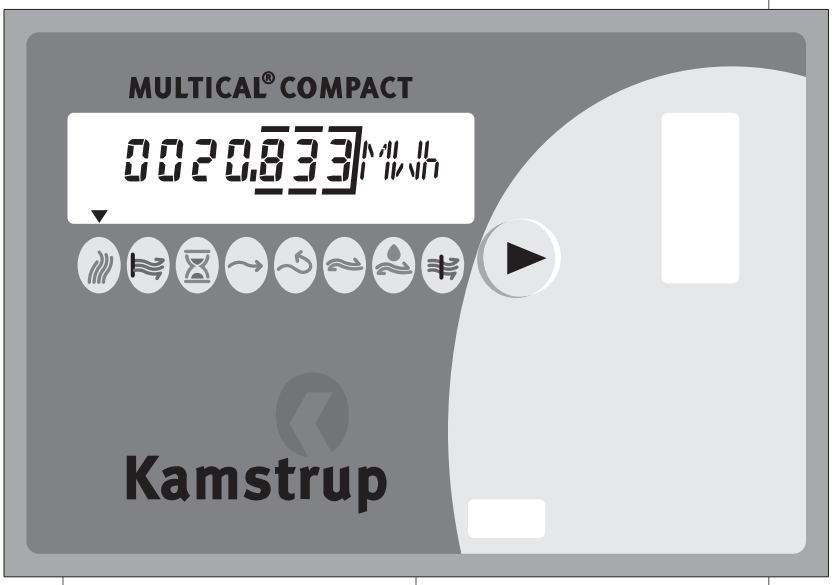
Numbering
Our temperature sensors are marked with a label carrying the catalogue and serial number of each sensor. The sensors are ordered and supplied in pairs.

Each sensor has a serial number, which appears from the label. The return sensor has the same serial number as the flow sensor.

3. Type number

The number system below describes the way in which MULTICAL® Compact is built up with a view to ordering.

1.1 Type number
66-Kx-xxx-xxx



1.2 PROG
A-B-CCC
Serial no.

1.3 CONFIG
DD-E-FF-GG

1.4 DATA
– Customer no.
– Target date
– TL2
– TL3
– Peak Avr. tid
– RS232 adr.
– Date/time
– Telephone no.

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3.1 Type number

Type number: 66-K – X – X – X – X – XXX

- Comm. Module
  - None — 0
  - Data module, RS 232 — R
  - Mbus — S
  - Modem — T
- Supply module
  - None — 0
  - D-Cell, Lithium Battery — 1
  - 230 V AC — 3
  - 24 V AC/DC — 4
- Pt500 Sensor set
  - Short direct, 1.5 m cable — 5
- Flow part
  - G3/4B * 110 mm, qp 0.75 m^3/h and 1.5 m^3/h — A
  - G1B * 130 mm, qp 0.75 m^3/h and 1.5 m^3/h — B
  - G1B * 130 mm, qp 2.5 m^3/h — C
  - G3/4B * 165 mm, qp 0.75 m^3/h and 1.5 m^3/h — D
- Country Code — XXX

3.2 PROG, A-B-CCC

Programming No.: A – B – CCC

- Flow meter installation
  - Flow pipe — 3
  - Return pipe — 4
- Measuring unit
  - GJ — 2
  - kWh — 3
  - Mwh — 4
- Flow meter code
  - qp 0.75 m^3/h, qi 0.015 m^3/h — 826
  - qp 0.75 m^3/h, qi 0.0075 m^3/h — 827
  - qp 1.5 m^3/h, qi 0.03 m^3/h — 832
  - qp 1.5 m^3/h, qi 0.015 m^3/h — 833
  - qp 2.5 m^3/h, qi 0.05 m^3/h — 838
  - qp 2.5 m^3/h, qi 0.025 m^3/h — 839

3.2.1 CCC-table

	No. of decimals							
CCC No.	**kWh**	**MWh**	**GJ**	**m³**	**l/h**	**kW**	**qp (m³/h)**	**qi:qp**
826	0	3	2	2	0	1	0.75	1:50
827	0	3	2	2	0	1	0.75	1:100
832	0	3	2	2	0	1	1.5	1:50
833	0	3	2	2	0	1	1.5	1:100
838	0	3	2	2	0	1	2.5	1:50
839	0	3	2	2	0	1	2.5	1:100

3.3 CONFIG, DD-E-FF-GG

Configuration: DD – E – FF – GG

- Display set up — XX
- Tariff type
  - None — 0
  - Power-controlled — 1
  - Flow-controlled — 2
  - Cooling-controlled — 3
  - Forwarded energy — 4
  - Controlled by return temperature — 5
- Available — 00
- Available — 00

Primary display readings ‹DD›

Niveau 1 DD code	11	12	13	14	15	16	17	18	19	20	21	22
energy	1	1	1	1	1	1	1	1	1	1	1	1
water	2	2	2	2	2	2	2	2	2	2	2	2
hours	3	3	3	3	3	3	3	3	3	3	3	3
T flow	4	4	4			4	4	4	4	4	4	4
T return	5	5	5			5	5	5	5	5	5	5
∆ T	6	6	6			6	6	6	6	6	6	6
power	7	7	7			7	7	7	7	7	7	7
peak power	8	8	8	*	*	8	8	8	8	8		
year peak power									9	9		
flow	9	9	9			9	9	9	10	10	8	8
peak flow	* 10										9	9
year peak flow											10	10
all info	11											
info (-2)		10		4		10		10	11		11	
info (-2 & -128)			10		4		10			11		11
info (-128)												

Secondary display readings

Niveau A DD code	11	12	13	14	15	16	17	18	19	20	21	22
reading date 1	1					1	1					
energy	2					2	2					
water 1	3					3	3					
year peak power 1												
reading date 2	4					4	4					
energy 2	5					5	5					
water 2	6					6	6					
year peak flow 2												
TA 2								1	1	1		
TL 2								2				
TA 3								3	2	2		
TL 3								4				
prog no.	7											
customer no. date	8	1	1	1	1	7	7	5	3	3	1	1
date	9								4	4		
segment test	10	2	2	2	2	8	8	6	5	5	2	2

* Show peak power/peak flow (depended on DD-code) at reading.

3.4 Tariff functions

MULTICAL® Compact has two extra energy registers TA2 and TA3, which can accumulate energy parallel to the main register on the basis of an entered tariff condition. TA2 and TA3 always have the same measuring unit as the main register (kWh, MWh or GJ), except from E=4 [m³ x °C] which accumulates in the measuring unit [m³ x °C].

Independent of the selected tariff, the unit field always indicates TA2 and TA3.

As it is considered the legal accounting register, the main register is always accumulated independent of the selected tariff function. Tariff conditions TL2 and TL3 are checked before each integration, i.e. every 30 sec. If the tariff conditions are fulfilled, the thermal energy used is accumulated in either TA2 or TA3 parallel to the main register.

Each tariff function has two connected tariff conditions, TL2 and TL3, which are always used in the same tariff type. Therefore, it is impossible to "mix" two tariff types.

E =	Tariff type	Pil	Function
0	No tariff active	-	No function
1	Power tariff	7	Energy will be accumulated in TA2 and TA3 based on the flow limits in TL2 and TL3.
2	Flow tariff	8	Energy will be accumulated in TA2 and TA3 based on the flow limits in TL2 and TL3.
3	Cooling tariff	6	Energy will be accumulated in TA2 and TA3 based on the Δt-limits in TL2 and TL3.
4	$m^3 t_F + m^3 t_R$	-	TA2 = $m^3 \times t_F$ and TA3 = $m^3 \times t_R$
5	Return temperature tariff	5	Energy will be accumulated in TA2 and TA3 based on the t_R-limits in TL2 and TL3.

3.4.1 Tariff types

E= 0 No tariff active
If you do not wish to use the tariff function, select the set-up E=0.

E= 1 Power controlled tariff
If the actual heat flow rate (P), in kW or MW, exceeds TL2 but is lower than TL3, heat energy will be counted in both TA2 and the main register. If the actual power exceeds TL3, thermal energy will be counted in both TA3 and the main register.

P<TL2	Counting in main register only
TL3>P>TL2	Counting in TA2 and main register
P>TL3	Counting in TA3 and main register

During set-up of data, TL3 must naturally be higher than TL2.

Among other things the power controlled tariff is used as a basis for calculating the individual heat consumer's connection costs. Furthermore, this tariff form can provide valuable statistical data when the heating station evaluates new construction activities.

E= 2 Flow controlled tariff
If the actual flow (Q), in l/h or m³/h, exceeds TL2 but is lower than TL3, heat energy will be counted in both TA2 and the main register. If the actual power exceeds TL3, heat energy will be counted in both TA3 and the main register.

Q<TL2	Counting in main register only
TL3>Q>TL2	Counting in TA2 and main register
Q>TL3	Counting in TA3 and main register

During set-up of data, TL3 must naturally be higher than TL2.

Among other things the flow controlled tariff is used as a basis for calculating the individual heat consumer's connection costs. Furthermore, this tariff form can provide valuable statistical data when the heating station evaluates new construction activities.

E= 3 Cooling tariff (Δt)
If the actual cooling (Δt), in °C, is lower than TL2 but exceeds TL3, heat energy will be counted in both TA2 and the main register. If the actual cooling gets lower than TL3, heat energy will be counted in both TA3 and the main register.

Δt>TL2	Counting only in main registe
TL3<Δt<TL2	Counting in TA2 and main register
Δt<TL3	Counting in TA3 and main registert

During set-up of data, TL3 must naturally be lower than TL2.

The cooling tariff can be used as the basis for weighted user payment. Low cooling (small difference between forward and return temperature) means bad economy to the heat supplier.

E= 4 Supplied energy
If this function has been selected, the product of water volume and forward temperature [m³ x °C] is calculated and accumulated in TA2. The resolution of TA2 is integer m³ × integer °C.

TA2 =	$m^3 \times t_F$ [°C]
TA3 =	$m^3 \times t_R$ [°C]

This tariff type uses neither TL2 nor TL3.

This function can be used to calculate the averagely forwarded temperature through dividing TA2 by the volume register for the period, for which an examination is required.

E= 5 Return temperature tariff

If the actual return temperature (t_R) in °C, exceeds TL2 but is lower than TL3, heat energy will be counted in both TA2 and the main register. If the actual return temperature exceeds TL3, heat energy will be counted in both TA3 and the main register.

t_R<TL2	Counting in main register only
TL3>t_R>TL2	Counting in TA2 and main register
t_R>TL3	Counting in TA3 and main register

During set-up of data, TL3 must naturally be higher than TL2.

The return temperature tariff can be used as basis for weighted user payment. A high return temperature indicates insufficient heat utilization and therefore means bad economy for the heat supplier.

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4. Data communication

4.1 Optical reading

An optical, infrared receiver/transmitter is situated in the bottom right hand corner of the front panel of MULTICAL® Compact. The data format fulfils IEC 870 in start mode and can then be converted into a producer specific format.

A standardized optical reading head with a permanent magnet is used for data reading and configuration of tariff limits.

Flow meter position and selection of measuring unit for accumulated energy can also be programmed by means of the optical reading head. To be able to change this data, however, an internal connection must be made before programming as the data in question is legal measuring data.

If data cable type 66-99-108 or verification equipment type 66-99-28x are used, the internal connection are integreated.

KAMSTRUP's reading head, type 66-99-102, can be connected to KAMSTRUP's hand terminal, MULTITERM III, as well as a standard IBM compatible PC with Windows 95 or a newer version installed.

Concerning further information on the functions of hand terminal and programming software we refer to documentation on:

MULTITERM type 66-99-15X

METERTOOL type 66-99-702

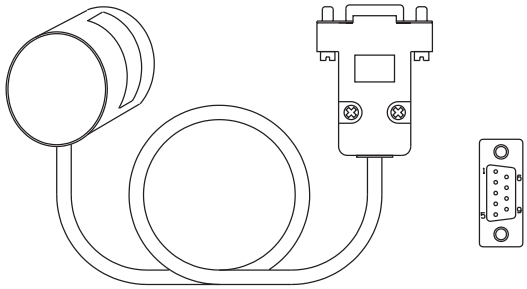
Functioning
When the connected reading unit, MULTITERM or PC, sends a recognizable request string, MULTICAL® Compact answers with a data string 1-2 seconds after having received the request string.

MULTICAL® Compact's optical data reading uses the following communication set-up:

300/1200 baud, 1 startbit, 7 databits, even parity, 1 stop bit.

NB: Both 1 and 2 stop bit can be used.

Note: Except from Optical reading, section 4.2, the other data strings neither contain measuring units nor placing of decimals. These can be seen in the CCC-table in this Technical description.



Standardized optical reading head

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4.2 Optical data reading

Following data can only be read through the optical eye placed on the front of MULTICAL® Compact.

Command (300BAUD)	Return String (300BAUD)
/?! [CR] [LF]	/KAM [SP] MCC [CR] [LF] [STX]0.0(xxxxxxxxxx) [CR] [LF] 6.8(E1-E2 * unit) [CR] [LF] 6.26(Vol1 * m^3) ! [CR] [LF] 6.31(Operating hours * h) ! [CR] [LF] [ETX] [BCC]

In general, the reading is build up according to EN61107/IEC1107, Mode A, but BCC is calculated arithmatically as on M-Bus and not as module 2.-binary sum ISO1155.

4.3 Data strings

Req	STANDARD DATA 1									
/#1	Energy	Volume	Hours	tF	tR	tF-tR	Power	Flow	P-power/flow	Info
	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii

Req	STANDARD DATA 2									
/#2	Cust. No.	TA2	TL2	TA3	TL3	-	-	ABCCC	DDEFFGG	Date
	11 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii

Req	TARGET DATA								
/#3	Cus. No.	Target date	Energy	Volume	TA2	TA3	-	-	Year Peak
	11 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii

Req	MONTHLY DATA								
/#5	Cust. No.	Calender	Energy	Volume	TA2	TA3	-	-	P-power/flow
	Time data								
		Calender	Energy	Volume	TA2	TA3	-	-	P-power/flow
	1 month back								
		Calender	Energy	Volume	TA2	TA3	-	-	P-power/flow
	2 months back								
							-	-	
							-	-	
	11 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii	7 ascii
	25 months back								
	26 blank								
	27 blank								
	28 blank								
	29 blank								
	30 blank								
	31 blank								

5. Verification

In order to be able to carry out test/verification of MULTICAL® Compact with a minimum use of time the meter has a testing mode. When the meter is in testing mode the program runs approx. 4 times faster than in standard mode. Testing mode also has some extra functions as described below. (NOTE: MULTICAL® Compact uses approx. four times more current in verification mode. However, this has no influence on the total lifetime of the meter).

Flow verification
Conditions – The temperature of the medium must be equal to the flow or return temperature, depending on the programming.

A simulation sensor can be used as follows: A simulated sensor of 51.5°C at a temperature of the medium of 50 ... 53°C makes out an error of < 0.2%.

Three-piece verification
If verification is carried out by means of simulation resistors connected to the test plug, the sensors must be removed from terminals nos. 5-6-7-8.

Verification mode [sec.]	Process
8	Volume and energy measurement
0	Flow measurement
0.5	Flow measurement
1.0	Flow temperature
1.5	Flow measurement
2.0	Flow measurement
2.5	Return temperature
3.0	Flow measurement
3.5	Flow measurement
4.0	Measuring references
4.5	Flow measurement
5.0	Flow measurement
5.5	Flow measurement
6.0	Flow measurement
6.5	Flow measurement
7.0	Flow measurement
7.5	Delay
8.0	Volume and energy measurement
0	Flow measurement

5.1 Verification mode

Functions in testing mode

Extra indications
Apart from the display indications in standard mode there are two extra testing counters for energy and water respectively. The testing counters appear as extra indications immediately after the main counters for energy (E) and water (Q). The resolution of the extra testing counters is for energy (E') 10 [mWh] and for water quantity (Q') 1 [ml]. The main counters do not change unit or resolution.

Testing mode
The meter can be switched to testing mode by pressing the internal button marked "P" for approx. 1 sec. or serially through the test plug in the meter. When the meter is in testing mode a "P"

appears farthest to the left in the meter's display.

The internal push button is placed under the top cover. When the internal push button is activated the meter changes to verification mode, whereas subsequent activation for 3 seconds brings the meter back to standard operation.

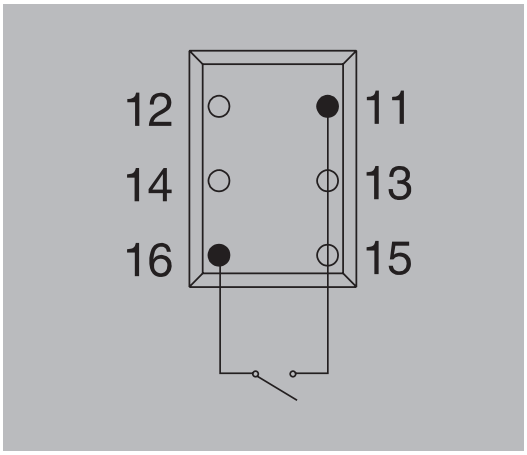
If both the internal push button and the front key are activated at the same time an auto-integration sequence starts in the meter (see paragraph 5.2 Auto-integration).

To be able to operate the internal button or the test plug, modules or seals, if any, above the test plug must be removed.

Reset of testing counters Q' and E'
The extra counters can be reset by pressing the internal button marked "P" or serially. When resetting the testing counters internal energy and water rest in the meter are also reset. This means that accumulated energy and water may be missing in the main counters after repeated resets.

Standard mode
The meter can be changed to testing mode by pressing the internal button marked "P" for approx. 3 sec. or serially through the test plug in the meter. If the meter is not brought back to standard mode, it will automatically change to standard mode after 9 hours. When the meter has returned to standard mode the "P" which earlier appeared in the left side of the meter's display will go out. Instead an "E" may appear in the left side of the display (see paragraph 2.4 Information codes).

External control of testing counters Q' and E'
It is possible to control the testing counters externally by means of a contact function. The contact must be connected to pins 16 and 11 of the test plug.



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The function is carried out as follows:

1. When the connection is established verification registers Q' and E' are reset, and the counting starts.
2. When the connection is released, the verification registers Q' and E' are locked.
3. Subsequently the registers can be read from the display or serially.
4. A new test point can be carried out starting from point 1.

5.2 Auto-integration

When the meter is in testing mode auto-integration can be started by simultaneously pressing the display change button and the internal button marked "P" for approx. 0.5 seconds.
Auto-integration can also be started serially through the testing plug.

If the function is started manually, the meter automatically carries out an energy calculation corresponding to a flow quantity of 100 l and 10 energy calculations with the current temperatures. This test takes approx. 20 sec. Once an auto-integration has been started it cannot be interrupted.

5.3 Energy calculation

NB.: Only possible when 7-8 is short circuitet see PTB 1998-11-18 Prüfanweis.
The "true" energy supplied to a MULTICAL® Compact during verification must be calculated very accurately as the "true" energy forms the basis of the meter's verification deviation. The energy can be calculated as follows:

$E_{MJ=}$	$m^3 \times \Delta t \times k_{STUCK}$	[MJ]
$E_{GJ=}$	$\frac{E_{MJ}}{1000}$	[GJ]
$E_{kWh=}$	$\frac{E_{MJ}}{3.6}$	[kWh]
$E_{MWh=}$	$\frac{E_{MJ}}{3600}$	[MWh]

m^3
is the water quantity applied (or simulated) during verification.

Δt
is the difference between the flow and return temperature ($t_F - t_R$). No matter whether the verification is carried out with the sensors in liquid bath or with precision resistors, the temperatures must be entered with great accuracy.

k_{STUCK}
is the heat coefficient of the water, which is found in the tables of "Tabellen von Wärmekoeffizienten für Wasser als Wärmeträgermedium", issued in 1986 by Wirtschaftsverlag NW.

Before looking up the k-value the following information must however be available:

– Forward temperature, t_F

– Return temperature, t_R

– Flow meter position: forward or return pipe

– System pressure (1 or 16 bar, or an interpolation in between)

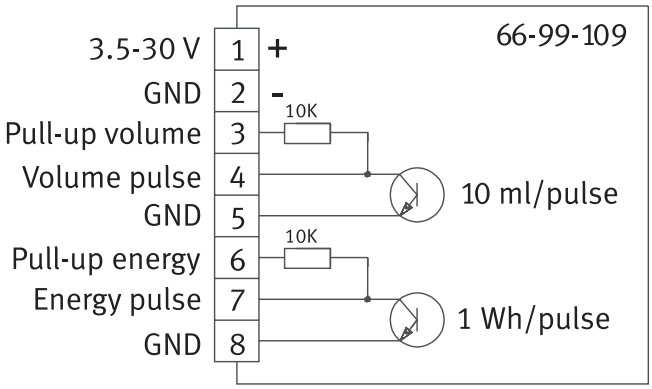
The k-factor is stated in the table as a basis for energy measurement in MJ and must therefore be converted in accordance with the above-mentioned formulas if the energy should be expressed in other measuring units.

Only passive precision resistors can be used for test and verification of MULTICAL® Compact. An electronic resistance simulator, e.g. based on a power controlled FET is not suitable as MULTICAL® Compact is intermittent (bursting).

5.4 Pulse Interface for MULTICAL® Compact

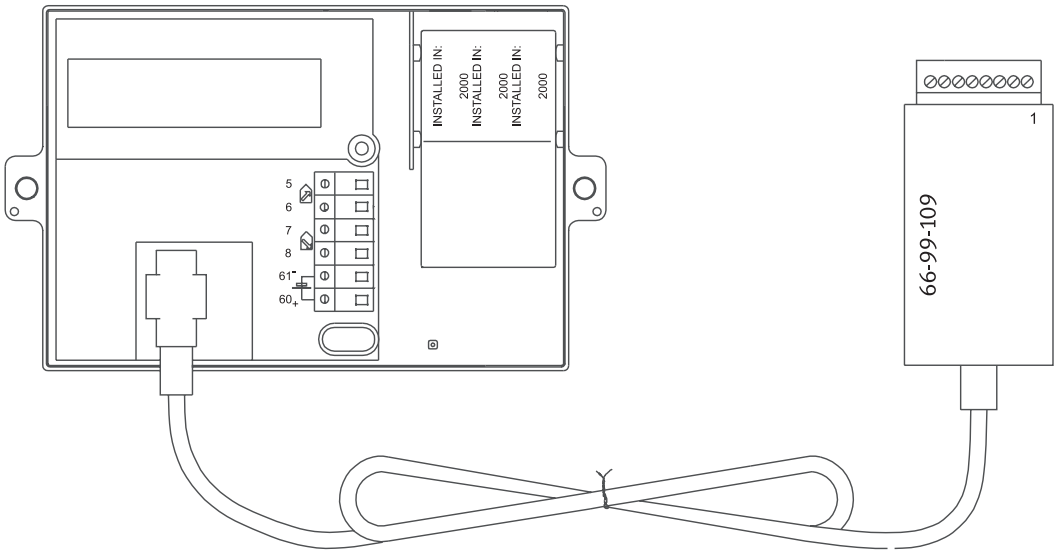
At energy verification on a bench with pulse interface, the pulse interface type 66-99-109 are to be used.

Pulse Interface for MULTICAL® Compact
Type: 66-99-109



Supply:	3.5-30 VDC < 5 mA
Stand-by:	<100 mA
Pulses:	<30 V < 15 mA
Length:	50% Duty cycle or pulse < 0.1 sec.
Resolution:	10 ml/pulse – 1 Wh/pulse

MULTICAL® Compact



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6. METERTOOL

6.1 Programming via METERTOOL

METERTOOL for MULTICAL® Compact is a Windows software, which can be installed on a PC and used to program and verify the calculator. METERTOOL is devoloped with a view to offering distributors, heating plants and laboratories a simpel and effective access to programming and verification of the integrator.

6.1.1 PC and printer requirements

METERTOOL is suitable for installation under Windows 95/98/NT/2000 on Pentium based PCs with at least 16 MB RAM, 20 MB free hard disk and VGA monitor min. 640 x 480. Recommended 800 x 600 or higher.

In order to be able to install the program, the PC must be equipped with a 680 MB CD-drive.

To facilitate programming of MULTICAL® Compact, serial data connection (COM-port) between the calculator and PC is used. An IR head type 66-99-102 can be used for configuration. If verification equipment type 66-99-28x is used both programming and verification can be made.

With all types of connection, the program can be set up to use the PC's COM1...4.

The program can also be used for printing labels for MULTICAL® Type 66-CDE. The printer must be compatible with Windows and be suitable for printing small self-adhesive label sheets.

The printer is connected to the computer's parallel port, LPT1.

KAMSTRUP A/S recommends e.g. an OKI 610ex, OKI 410ex or a HP4 laser printer, but other printer types can also be used.

Sheets with original self-adhesive labels, type 2008-245, can be ordered from KAMSTRUP A/S.

6.1.2 Installation of software

Please check that the computer has min. 20 MB free space on the hard disk, e.g. by means of Windows File Manager. Close all active Windows programs before installing the program.

Insert the CD in the drive and follow the program's instructions as they appear on your screen.

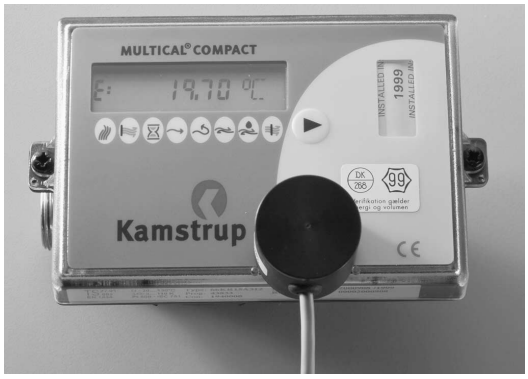
When the installation is completed, the icon "METERTOOL" will appear in the Start menu. Double click on the new icon "METERTOOL" to start the program.

Please note: If the right printer driver is not installed, the program will not be able to print labels or certificates.

6.1.3 Connecting MULTICAL® Compact to PC

The calculator is programmed for serial data transmission between the calculator and the computer. The data can be transmitted by means of optical IR head type 66-99-102 or verification equipment, e.g. type 66-99-287. Data cable type 66-99-108 can also be used.

Optical IR head type 66-99-102
The optical head is placed between the two pins on the front of the calculator where it is held in place by means of a magnet. The IR head cable must always point downward ±20°. The optical IR head MUST NOT be used or stored near diskettes or computers as the magnet can damage the data. Always cover the magnet with the protection plate when it is not in use.



The optical head, combined with a lap-top computer is the ideal way to program the meter. E.g. new tariff limits can be programmed quickly and simply on site without removing the energy meter. If MULTICAL® Compact is furnished with a plug-in communication module, e.g. M-Bus programming via the optical head may be non-functional. In these cases, we would recommend that you use the verification equipment for the task.

If the computer has a 25-pole COM-plug, a 9M/25F adapter, type 66-99-120 must be used.

Verification equipment type 66-99-28x
See section 6.2 *Verification via METERTOOL* for further information.

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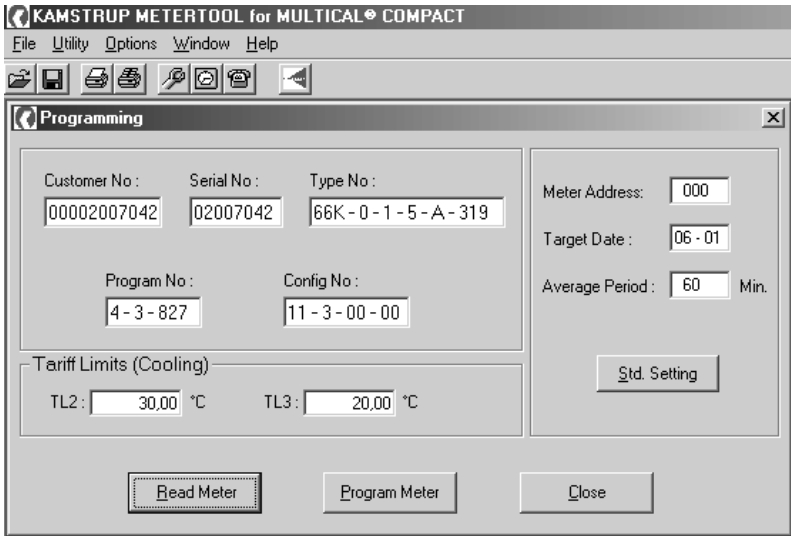
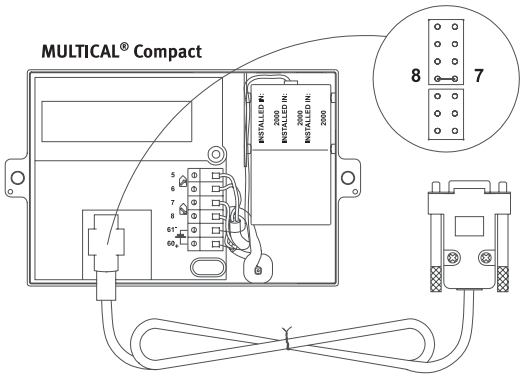
6.1.4 Reading MULTICAL® Compact

Connect the serial data communication as described in previous paragraph and start the program by clicking on the icon “METERTOOL”. Choose the button “Read meter” and data will be transmitted from the meter and shown on the monitor.



Partial programming
If the programming lock in MULTICAL® Compact (indicated by a ring in the diagram below) is open, the meter can only be partially programmed.



The limitation means that the legal parameters A-B-CCC and type and serial number can not be changed, while all other data can be programmed as required. This limitation is used to prevent the original operating parameters from being changed on type approved and verified meters.

National verification demands must be checked before the integrator’s verification seal is broken.

Complete programming
If the programming lock is short-circuited, it is possible to reprogram MULTICAL® Compact, incl. the legal data A-B-CCC and type- and serial No.

When data cable type 66-99-108 or verification equipment 66-99-287/66-99-288 is used, the programming lock is short-circuited.

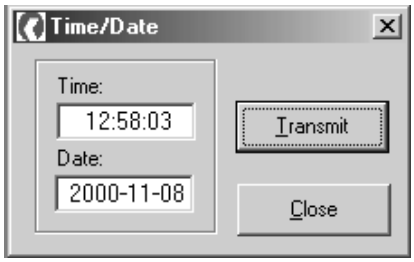
NB. When connecting the test plug it automaticaly breaks the verification seal. Sealing must be carried out by an authorized laboratory.

Please note that the data logging memory in the calculator can not be changed/erased during programming, unless this is selected in the software.

6.1.5 Programming

It is important that you are familiar with all calculator functions before programming.

All necessary information appears in this Technical description.

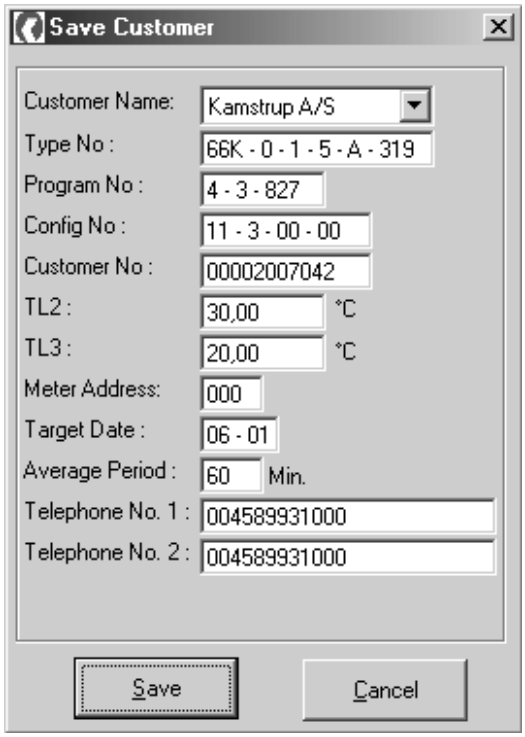


Furthermore, you must check the computer’s internal clock before programming - date and time will be transmitted from the PC to the calculator when you program “Time/Date”.

6.1.6 File

Under the menu “File” one of the following functions can be selected:

Open Customer	Get stored customer settings from the data base.
Save Customer	Save new customer settings in the data base.
Print Certificate	Starts print of test certificate.
Print Label	Starts print of front label.
Print Setup	Printer setup for printing front label and certificate.
Exit	Terminates METERTOOL.



6.1.7 Utility

This menu gives access to the following dialog boxes:

Programming — General view which is used when reading and programming.

Time/Date — The PC's date and time is transmitted to MULTICAL® Compact.

Telephone No. — 2 different telephone numbers can be programmed in MULTICAL® Compact.

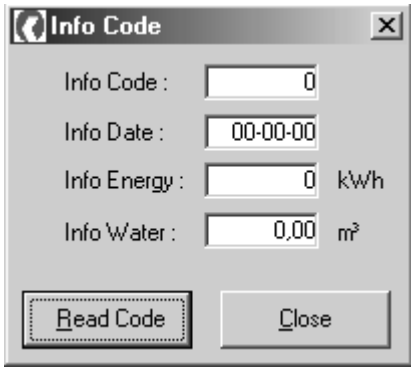
Info Code — Is used for reading the info code.

LogView — Makes it possible to read data and export log-files.

Reset — Reset all dataloggers if the programming lock is short-circuited.

Verification — See section 6.2 *Verification via METERTOOL*.

Flow meter adjustment — Is only used when adjusting flow meter (requires password).

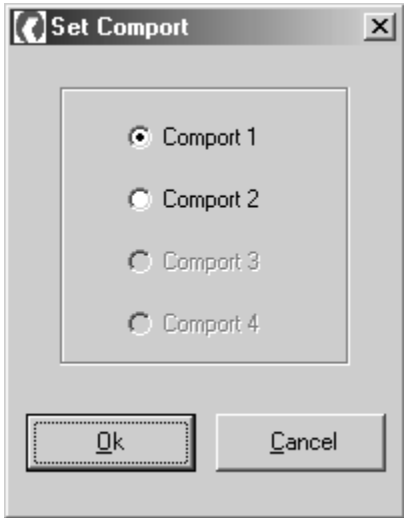


6.1.8 Options

The menu has a few settings which are not used very often:

Verification data — See section 6.2 *Verification via METERTOOL*.

ComPort — Indicates the choice of Com1...4



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6.2 Verification via METERTOOL

Equipment description
Verification equipment type 66-99-28x is used for testing and verifying the MULTICAL® Compact calculator. The test includes volume simultation and simultation of temperature for T1 - T2. These form the basis of verification of the energy calculation.

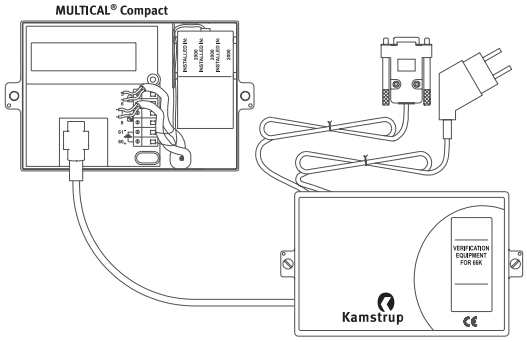
The equipment is primarily designed for use in laboratories which test and verify energy meters, but it can also be used to test meter operation.

The computer program METERTOOL type 66-99-702 is used to configure, test and verify.

All data communication between the computer and the integrator is transmitted via the computer's serial ports; COM1...4, which are connected to the verification equipment. Please note that the equipment must be supplied via the associate mains adapter.

The computer must comply with demands specified in section 6.1 *Programming via METERTOOL*.

Verification does not include temperature sensors and the flow part.



The verification equipment is supplied in 2 different types containing power supply, data cable and calibration certificate.

66-99-287 Standard (EN1434) Type 66-K	T1 [°C] 130 80 43	T2 [°C] 20 60 40

66-99-288 OIML R75 Type 66-K	T1 [°C] 130 80 49	T2 [°C] 20 60 40

6.2.1 Function

Verification equipment type 66-99-28x is mounted in a standard MULTICAL® base and contains battery, connection print, verification print, microprocessor, control relays and precision resistors.

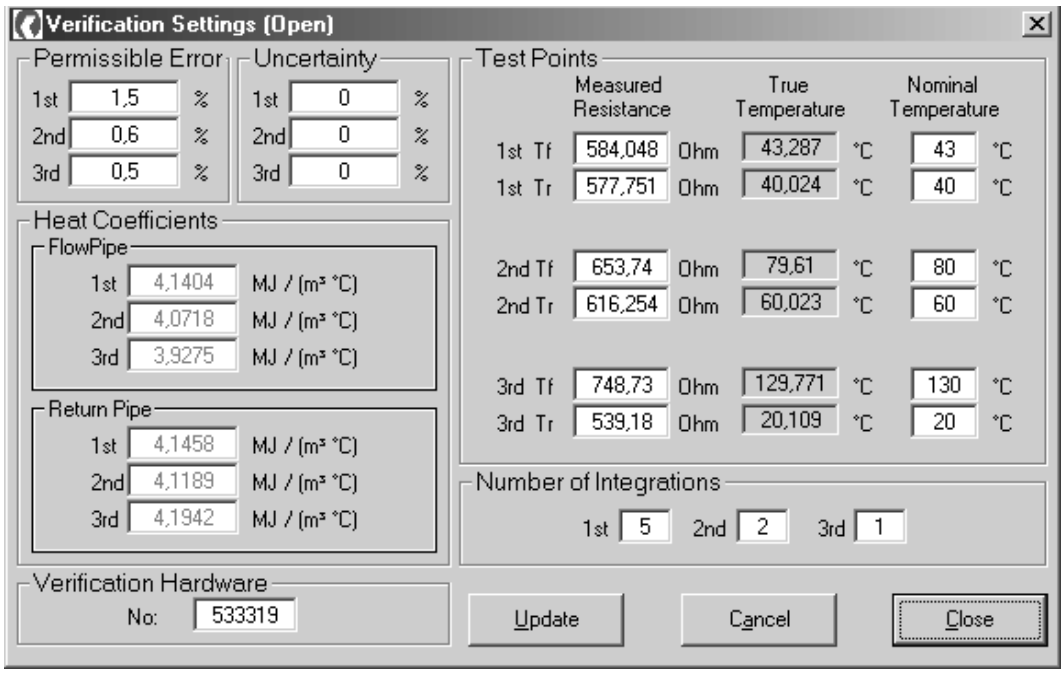
Connection between verification equipment and MULTICAL® Compact is done by the use of an 14-pole test plug.

During the test the calculator is supplied by the battery. The verification print is supplied via the associate external mains adaptor with 12 VDC. The microprocessor simulates the volume based on the number of integration per test point, which have been selected in the computer program. Temperature is simulated by means of permanent precision resistors which are changed automatically via relays controlled by the micro-processor.

After testing the computer reads all registers in the calculator and compares the values with the calculated values.

Deviation, determined for each test point - shown as a percentage - can be printed on a test certificate or stored in the computer under the serial number of the tested MULTICAL® Compact.

While the verification equipment is connected parallel to the temperature sensor terminals, the sensors must be disconnected before starting verification. Remember to reconnect the sensors after verification.



6.2.2 Verification data

The first time that METERTOOL and the verification equipment are used, a number of calibration data must be entered in the menu “Verification data”. As these data are of crucial importance for the verification result, they are protected by a password which can only be disclosed by Kamstrup A/S.

Permissible error and uncertainty
Max. permissible error, indicated as a percentage, and the equipment’s measuring uncertainty must be indicated under each of the three verification points; 1st, 2nd and 3rd. The “permitted error” minus “uncertainty” will be indicated as MPE on the verification certificate. According to EN 1434 is MPE $\pm(0.5 + \Delta\theta \text{ min}/\Delta\theta)\%$.

Heat coefficient in flow and return
When the calibration values for the temperature simulators are entered in the program, it automatically calculates the true k-factor, according to the formula in EN 1434.

Test points
The test points 1st, 2nd og 3rd are determined by the size of the temperature simulation resistances fitted in the test equipment. The rated temperature points are indicated in the preceeding paragraph.

Measured resistance
In order to update the temperature simulators’ calibration, the temperature resistances’ latest measured resistance values are entered. A calibration sheet with declaration of measured resistance values for all simulators is supplied by Kamstrup A/S together with the verification equipment. The temperature simulators must be calibrated at Kamstrup A/S once a year.

Enter number of integrations
Enter the number of integrations required at each test point in this field. Minimum required no. of integrations is 5,2 and 1 concerning 1st, 2nd and 3rd test.

6.2.3 Verification

All necessary information can be transmitted directly from the calculator via serial data transmission, which simplifies verification. Before test or verification can be started, a control must be made to confirm that all verification data are correct. The procedure is started by clicking on “Start test”.

The test takes between one and five minutes depending on the test type selected and the numbers of integrations.

When the test is completed, the results are shown on the monitor. If the results can be approved, click on “Save” and all verification data will be stored in the data base under the calculator serial number. It is possible to save data both on verification and control.

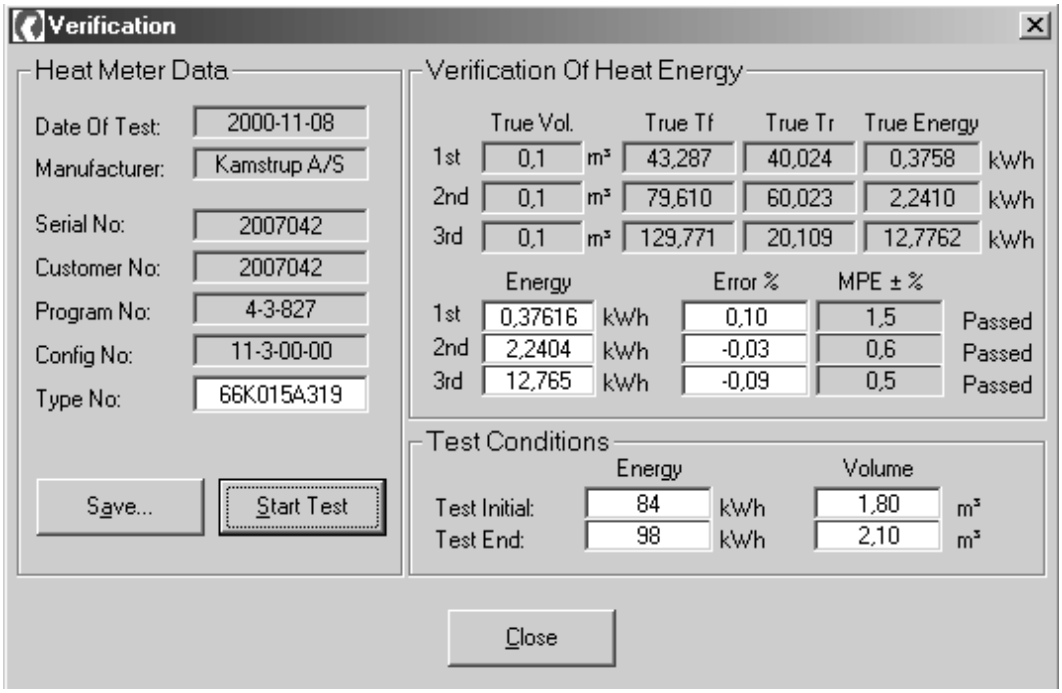
NB: Type No. must be typed in before “Save”.

If a printed certificate with the test results is desired, select “Print” from the “File” menu, and the required serial number is choose.

6.2.4 Maintenance

Verification equipment type 66-99-28x is designed to work a number of years with a minimum of maintenance. The following must, however, be executed frequently in order to secure optimal operation:

Recalibration
On delivery, a calibration certificate is enclosed issued by Kamstrup A/S. The applied calibrated resistance values must be entered under “Verification data”. The equipment must be recalibrated at least once a year.



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CERTIFICATE OF CALIBRATION

Verification Equipment for MULTICAL® / MULTICAL® Compact

Customer: **Kamstrup A/S, Industrivej 28, DK-8660 Skanderborg, Denmark**

Type No.: **66-99-287** Type of meter: **66-K**

Serial No.: **533319**

Procedure: Kamstrup A/S No.: 5509-405

Test equipment:
DMM, Datron 1271 Kamstrup A/S No.: 14-021-010
Standard resistor, Vishay RTB 10 Kamstrup A/S No.: 14-061-020

This certificate provides traceabilty of measurement to recognised national/international standards.

Expanded Uncertainty: ± 15 ppm

Measurements:

		Nominal temperature [°C]	Nominal resistance [ohm]*	Measured resistance [ohm]	Calculated temperature [°C]*
T1	t_F	43	583.495	584.048	43.287
	t_R	40	577.704	577.751	40.024
T2	t_F	80	654.484	653.74	79.61
	t_R	60	616.21	616.254	60.023
T3	t_F	130	749.16	748.73	129.771
	t_R	20	538.968	539.18	20.109

* According to IEC 751/EN 60751 Amendment 2, 1995-07 “Industrial platinum resistance thermometer sensors”

Date: **18-08-2000** Calibrated by: **JDO** Tamb.: **22.7** °C

5509-404 Rev. F1, Kamstrup A/S, DK-8660 Skanderborg

6.2.5 Flowmeter Adjustment

Should it be nessesary to adjust the flow meter during verification, this can be carried out by choosing “Flow meter Adjustment” in the “utility” menu. This function is protected by a password, which can only be optained by contacting Kamstrup A/S.

Data connection between PC and MULTICAL® Compact can be done by means of data cable type 66-99-108 or verification equipment type 66-99-28x.

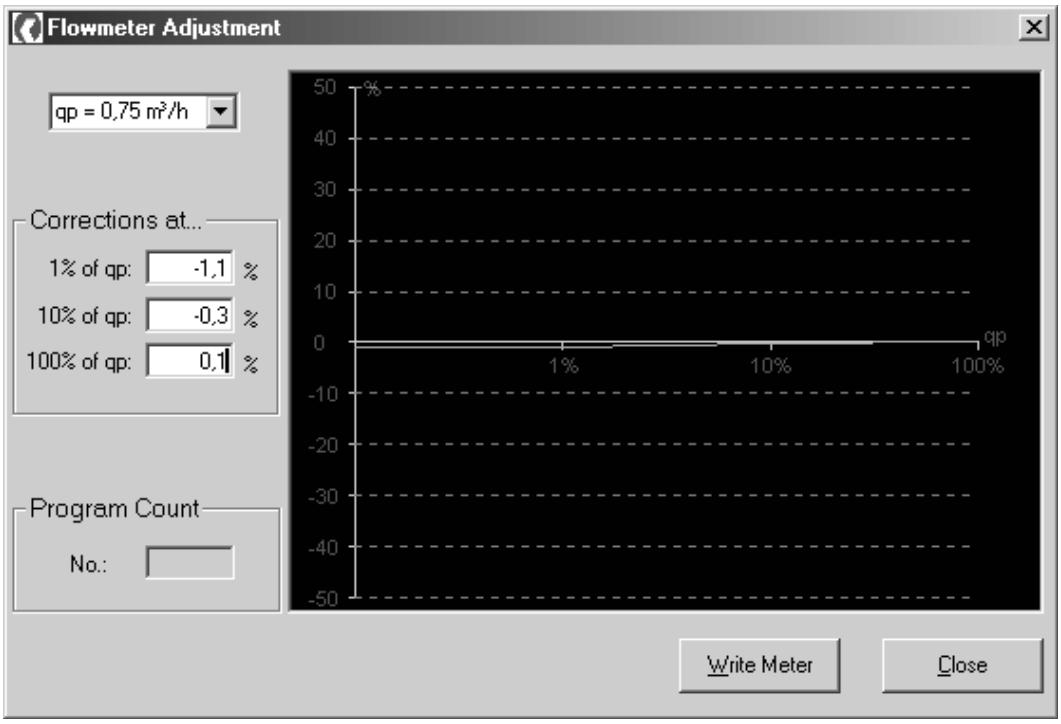
E.g: Verification of a MULTICAL® Compact flow meter shows the data below:

1% of qp:	+1.1%
10% of qp:	+0.3%
100% of qp:	-0.1%

To adjust the deviation following corrections must be typed in:

1% of qp:	-1.1%
10% of qp:	-0.3%
100% of qp:	+0.1%

Adjustments larger than ± 5% should not be carried out, while the deviation might be caused by a faulty flow meter.



6.2.6 Alphabetical register

The following alphabetical register explains the terms which appear on the monitor.

The register can both read as an integral art of the Technical Description, or used as a reference when a question arises.

A

A-B-CCC — The calculator’s programming number. Determines the flowmeter’s placement in flow or return, measuring unit and flowmeter sizes.

Address — (RS232) The calculator contains an addressable data sequence which can be used when several meters are connected in one mains, e.g. via external RS232/485 converters.

Average — Indicates the averaging period, of which the peak flow or power is measured.

C

CCC — Flow meter size. E.g. CCC=833 is used with qp 1.5 m³/h.

Com 1...4 — The computer’s serial data port number 1, 2, 3 or 4.

Config. No. — The meters configuration number = DD-E-FF-GG indicates display reading and tariff type.

Customer No. — 11-digit customer number which can be read on the display. The customer number can be changed without changing the serial number.

D

Date — The computer’s calendar which is transferred to the calculator. The format is YY-MM-DD.

DD — Display code which indicates the display reading selected.

DD-E-FF-GG — The meters configuration number = DD-E-FF-GG indicates display reading and tariff type.

E

E — The required tariff is selected by means of “E”. E.g. E=3 means “cooling tariff”, whereas E=0 means “no tariff”.

EN1434 — European standard for heat meters.

Energy — The total energy (e.g. In kWh) is stored in the memory when the info code is changed.

F

FF — Not used.

Flow — The actual flow of water meter V1 can be used as tariff basis (E=2).

G

GG — Not used.

I

Info code — The information code can be read.

Info date — The date when the information code appeared.

L

Landscape — Means that sheets with front labels will be printed horizontally.

M

Min — The number of minutes selected as average time for peak flow or peak power.

Between 1 ... 120 minutes can be chosen.

mm — The number of milimeters the front label’s print must be adjusted.

MPE — (Maximum Permissible Error) Max. permitted error.

P

Power — The actual heat power can be used as tariff basis (E=1).

Print — Starts print of the lable displayed.

Programming — Starts programming the meter. All the data displayed will be transmitted to the meter.

R

Read meter — Reads the meters setting. All the meter’s data are transmitted to the display.

RS232 — (Address) calculator contains an adressable data string which can be used if a number of meters are connected in one mains, e.g. via external RS232/485 converters.

S

Save Customer — Stores a setting in the data base.

Serial No. — The meter’s serial number.

Start test — This command is used to start the automatic verification sequence.

T

Target date — The yearly target date which most often is the district heating company’s billing date. On the target date all relevant registers are stored for later reading. The format is MM-DD, where MM=1...12 and DD = 1...28.

Tariff limits — The tariff limits decide when the tariff registers TA2 and TA3 must accumulate energy parallel with the energy reading. The tariff limits are only used with E=1, 2, 3, 4 or 5.

Test initial — Registers the value before verification.

Time — The computers actual time which is transmitted to the meter at programming.

TL2 — Tariff limit 2 indicates the start conditions for TA2.

TL3 — Tariff limit 3 indicates the start conditions for TA3.

Type No. — The meter’s type number contains information on power supply, data module, sensor type, pick-up unit and language on the front label.

7. Service and Error Detection

MULTICAL® Compact has been constructed with a view to fast and simple mounting as well as long-term, reliable operation at the heat consumer.

Should you, however, experience an operating problem with the heat meter, the error detection table below can help you clarify the possible reason.

We recommend that only battery and temperature sensors are replaced during service, alternatively the whole heat meter must be replaced.

Repair on print level under the sealing cover is only possible in our factory.

Symptom	Possible reason	Proposal for correction
No display function. (Display blank)	No supply power; 3.6 VDC on terminals 60-61	Replace battery. Check power supply.
No energy (e.g. MWh) or m³ accumulation	Read “Info” from the display If “info” = 000 If “Info” › 000	 Check flow meter direction and connection of temperature sensors. Check the error indicated by the Info-Code.
Accumulation of m³, but not energy (e.g. MWh)	Forward and return sensors have been reversed, either during installation or connection	Mount sensors correctly.
No m³ accumulation. Incorrect accumulation of m³.	Flow meter incorrectly mounted.	Check flow meter direction.
Incorrect temperature indication.	Defective temperature sensor.	Replace temperature sensor pair..
Temperature display is too low or accumulated little energy (e.g. Mwh) is too low.	Poor thermal sensor contact. Heat dissipation.	The sensors can only be used in ½” and ¾” pipes. Use fittings which are intended for direct sensors according to EN 1434. Insulate around the sensors.

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8. Environmentally correct disposal

The Kamstrup heat meter has been constructed with a view to long-term, reliable operation at the heat consumer. As we know, however, all good things come to an end, and the heat meter is no exception. It must , of course, be disposed of with consideration for the environment.

Disposal by the supplier
Kamstrup can accept MULTICAL® Compact for environmentally correct disposal according to previous agreement.
The disposal is free of charge to the customer, who must however pay the transportation costs to Kamstrup A/S.

Disposal by the customer
The lithium battery must be removed from the meter*) and sent to separate, approved destruction. It must not be possible to short-circuit the lead-in wires to the battery during transportation.

– If small quantities of meters are dismounted, the energy meter without battery can be handed in for industrial scrapping or for combustion with subsequent metal recycling.

– In case of dismounting of a big number of heat meters, the parts must be separated, sorted and handed in for separate destruction and recycling as described in the above-mentioned list.

*) Only battery supplied versions of MULTICAL® Compact. Mains supplied versions do not include lithium batteries.

Please send any questions you may have concerning environmental matters, to:

Kamstrup A/S
Att.: Quality Control Dept.
Fax: +45 89 93 10 01
E-mail: energi@kamstrup.dk

Part	Information on materials	Recommended disposal
Lithium battery in MULTICAL® - D-cell	Lithium and Thionyl-cloride >UN 3091< - D-cell: 4.9 g lithium	Approved destruction of lithium cells
PC boards in MULTICAL® and ULTRAFLOW® (LC-display and electrolytic capacitor are removed)	Copper epoxide laminate with soldered components	PC board scrap for concentration of noble metals
LC-display	Glass and liquid crystals	Approved scrap centre for LC-displays
Electrolytic capacitor	Can contain PCB	Approved destruction of electrolytic capacitors
Cables for flow meters and sensors	Copper with PVC- or silicone mantle	Cable recycling
Plastic parts, cast	Noryle and ABS	Plastic recycling
ULTRAFLOW® meter case	Brass/red brass and stainless steel	Metal recycling
Packing	Recycled cardboard	Cardboard recycling

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